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1996-97 School Year

Biology 30 Information Bulletin

Diploma Examinations Program

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This document was written primarily for:

Students	✓
Teachers	✓ Biology 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta Education • General Public upon Request

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Purpose of the Bulletin

The purpose of this bulletin is to provide students and teachers of Biology 30 with information about the diploma examinations scheduled for the 1996-97 school year.

We encourage teachers to share the contents of this bulletin with students and to review the scoring criteria with them.

If you have requests, questions, or comments about the contents of this bulletin, please contact:

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Important Dates in the 1996-97 School Year

Administration of the Examination

Alberta Education is increasing the number of administrations of diploma examinations to accommodate students' examination needs more effectively. For the 1996–97 school year the following diploma examinations will be offered in Biology 30.

1997 Administrations	*Time**
Wednesday, January 29	9:00–11:30 A.M.
Friday, April 18	9:00–11:30 A.M.
Thursday, June 26	9:00–11:30 A.M.
Monday, August 18	9:00–11:30 A.M.

* The diploma examination is designed for a writing time of 2.5 h. Students may have an additional 0.5 h to complete the examination.

Please consult the *General Information Bulletin, Diploma Examinations Program*, for a complete schedule for all subject areas.

Scoring of the Examination

1997 Administration	*Scoring Dates***
January	February 12 (Head Markers) February 13 to 15
April	Tentatively April 19
June	July 6 (Head Markers) July 7 to 10
August	August 22

* * Dates are tentative and will be confirmed by telephone with markers.

Notes of Interest

Information About Markers

The written-response questions of the Biology 30 Diploma Examinations are marked by Biology 30 teachers selected from those who have been recommended as markers to the Student Evaluation Branch by their superintendents. To qualify for recommendation, a teacher must have taught the complete Biology 30 course twice, be teaching the course in the current school year, and have an Alberta or Northwest Territories Permanent Professional Teaching Certificate.

Often, more teachers are recommended as markers by superintendents than are required by the Student Evaluation Branch for any one marking session. The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (experienced markers and first-time markers are included)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation)

Teachers who can mark examinations written in French are particularly needed.

Teachers who wish to be recommended as markers for the diploma examinations should contact their superintendents by the following dates:

Diploma Date	**Contact Superintendent by**
January 1997	September 27, 1996
April 1997	November 8, 1996
June & August 1997	February 28, 1997

Item Writing and Field Testing

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Item writing takes place throughout the year and is a vital component of the diploma exam program. Field testing provides students and teachers with the opportunity to become familiar with the nature of questions they will encounter on future diploma exams. Only teachers who have been nominated by their superintendents are eligible to participate in these activities. Therefore, it is essential that **teachers who are interested in these activities should let their superintendents know by September 12, 1996.**

Reports

After each January and June administration of the Biology 30 diploma examination, copies of the *Examiners' Report* for that particular administration are sent to teachers in all senior high schools in Alberta. The report contains provincial results along with comments about student performance on the examination. Examiners' reports are designed for teacher use. If these reports can be made more useful in any way, contact Student Evaluation Branch.

School and Jurisdiction Statistical Reports are sent to each superintendent and senior high school principal after each January and June administration of the Biology 30 diploma examination. These reports provide detailed information on how well the students in their school district and school, respectively, did on the Biology 30 diploma examination. Teachers may use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Each year, the Student Evaluation Branch produces the *Annual Report, Diploma Examinations Program*. This report contains information about the results achieved by all students who wrote diploma examinations in the preceding school year. It also contains special studies on topics of interest. The first annual report (1989–90 school year) contains a study comparing achievement in various diploma courses. The second report (1990–91 school year) contains a study comparing the achievement of students who repeat diploma examination courses and rewrite diploma examinations with their achievement the first time and with the achievement of students who write only once. The third report (1991–92 school year) contains a study of participation rates in diploma examination courses. The fourth report (1992–93 school year) contains a study of English 30 students' application of conventions of language. The fifth report (1993–94 school year) presents a comparison of provincial participation rates in diploma examination subjects for the school years 1991–92, 1992–93, and 1993–94. The sixth report (1994–95 school year) examines declining enrollment of Grade 12 students. Each of these special studies will be of interest to teachers who are involved in interpreting diploma examinations results of their students.

Additional copies are available from the student Evaluation Branch. Phone: 427-0010 FAX: 403-422-4200
To call toll-free from outside of Edmonton, dial 310-000.

As of the 1995-96 school year, this report is available on the Internet at Alberta Education's Web Site (http://ednet.edu.gov.ab.ca).

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff is available to provide inservices or presentations related to diploma examinations or the interpretation of diploma examination results.

Student Use of Scientific Calculators

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students. Students are expected to provide their own scientific calculators.

NEW

Refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations. It is important to clarify with students exactly what they are allowed to have stored in their calculator memories.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see the *General Information Bulletin*).

Data Resources for Students

The Biology 30 diploma examinations contain tear-out data pages. Students should remove the tear-out data pages from the exams at the beginning of the writing session. These pages do not have to be returned with the exam booklets and answer sheets. The data presented are generic for all of the Biology 30 diploma exams provided during a school year; therefore, only some of the data are useful for any particular exam.

NEW

A new set of data sheets has been prepared for use beginning with the January 1997 diploma examination. It is provided in Appendix E.

Guide for Students

NEW A publication written for students called *Students First: A Guide for Students Preparing to Write the Biology 30 Diploma Examination* is available in each senior high school. See your principal or department head for the black line master. This publication contains suggestions for exam preparation and exam writing suggestions. The Student Evaluation Branch highly recommends that students and teachers examine this document early in the term to prepare for the Biology 30 Examination. Parents will also find this to be a useful publication.

Student Requests for Rescores

Students may request a rescoring of their diploma examinations. Before applying for a rescoring, students should check their Diploma Examination Results Statement to find out the distribution of marks. The mark on the machine-scored questions is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Students who decide to have an examination rescored must ensure that their application is received before the deadline specified on the results statement. The fee for rescoring each examination is $26.75, which includes GST. If a diploma examination mark is increased by 5% or more as a result of rescoring, the fee is refunded.

Student Requests for Rewriting

Students may rewrite a diploma examination in any regularly scheduled administration. Students must apply to the Student Evaluation Branch by November 15, 1996, and April 15, 1997, to be eligible to write the January and June diploma examinations. The tentative fee for rewriting each examination is $26.75, which includes GST. (For more details, see the *General Information Bulletin*.)

Biology 30 Information

Objectives of the Course

Biology 30 is intended for students who want to better understand the biology principles behind the natural events they experience and the technology they use in their daily lives. Biology 30 is an experimental discipline requiring creativity and imagination. The course is designed for students who are preparing for academic post-secondary studies.

Students of Biology 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of biological concepts by their increased ability to apply these concepts to relevant situations. They have learned to communicate in the specialized language of biology.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, in particular by the successful completion of Science 10 and Biology 20. These courses develop knowledge and skills that are prerequisite to success in Biology 30.

Standards

Students who achieve an *acceptable* standard of performance in Biology 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific inquiry by designing, observing, and interpreting simple laboratory and field investigations. They can readily interpret physiological, genetic, and ecological data that are presented in simple diagrams, tables, and graphs. They can translate word descriptions of biological processes into symbolic representations that facilitate solving simple quantitative genetic and ecological problems. These students can demonstrate an acceptable level of understanding of *equilibrium* by describing how the human nervous and endocrine *systems* regulate other body processes such as reproduction. They can show how environmental and genetic factors regulate *change* in the development of organisms. They can describe how cellular and molecular processes cause *diversity* in organisms. They can illustrate how populations interact with each other, thereby forming communities that over time are in *equilibrium* or a state of *change*. These students recognize and understand key biological and technological terms and therefore can interpret short reports of current biological issues. They can identify the scientific, technological, and societal components of biological problems and explain how these components interrelate in solutions. These students can compose clear and logical descriptive or explanatory statements about major biological issues.

Students who achieve a standard of *excellence* in Biology 30 receive a final mark of 80% or higher. In addition to meeting the expectations for an acceptable standard of performance, these students demonstrate their aptitude and interest in biology and feel confident about their abilities. They can readily interpret interrelated sets of data such as complex graphs and tables. They can analyze and evaluate experimental designs. These students can provide explanations of concepts that are specific but also comprehensive. They can simultaneously apply two or more biological concepts that cross major themes. They can demonstrate a thorough understanding of quantitative relationships and solve multistep numerical problems. When presenting scientific data, they select the most appropriate form. They can analyze complex open-ended issues that are of a new or unique nature. The contexts of these issues would most likely include current investigations of homeostatic mechanisms or current genetic research. These students are aware of a variety of viewpoints relating to the environmental and ethical issues in the field of science and technology. Exceptional students can communicate clearly and concisely, using appropriate scientific vocabulary, and can write compositions.

Examination Specifications

Each Biology 30 diploma examination is designed to reflect the *Biology 30 course* general learner expectations outlined in the *Biology 20–30 Program of Studies, Interim 1994, for Senior High Schools*. The general learner expectations are expressed in more detail by the specific learner expectations, which are organized into four units. Some questions on each diploma exam will assess achievement of specific learner expectations. Some questions will be based on the integration of several specific learner expectations.

All examination questions are organized into sets that relate to broad contexts. Therefore, a set of questions may assess students' ability to integrate several general learner expectations (GLEs). All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and /or STS connections.

The 1997 Biology 30 diploma examinations are constructed to place the following approximate emphases on the Biology 30 Course General Learner Expectations.

Knowledge The student can show that:	***Emphasis***
• humans use nervous and endocrine systems to maintain internal equilibrium among their systems while simultaneously interacting and maintaining equilibrium with the external environment	20–25%
• humans and other organisms have chemically regulated reproductive systems, which ensure survival of the species, and can describe how sexually transmitted diseases interfere with human reproductive function	10–15%
• cell differentiation and organism development are regulated by genetic and environmental factors and that natural processes can be changed by using reproductive technologies	5–10%
• cell division in vascular plants and animals promotes growth, genetic continuity, and diversity of organisms; and that genetic traits are inherited and expressed in predictable ways if chromosome segregation, assortment, and crossing over are taken into account	25–30%
• genetic information stored in DNA molecules directs the functions of organisms and that biotechnology can be used to influence genetic expression	10–15%
• gene frequencies within populations determine the composition of communities and that these gene frequencies may reach equilibrium or continue to change over time as populations interact	15–20%

Skills ***Emphasis***

The student can: 20–30%

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Connections Among Science, Technology, and Society (STS) ***Emphasis*** 20–30%

The student can:

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory, and explain the limitations of science and technology in answering all questions and solving all problems
- describe and evaluate the design and function of technological solutions to practical problems using scientific principles and theories, and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society, and assess the ability of society to interact responsibly with the environment
- apply the skills and knowledge acquired in Biology 30 to everyday life and to related and new concepts in post-secondary studies of biology

Examination Design

The design of the 1997 Biology 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	48	60
Numerical Response	8	10
Written Response	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions, some of which may be linked together.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Most of the multiple-choice questions are *context-dependent*.

A particular context may be used for more than one multiple-choice question, one or more numerical-response questions, as well as for one written-response question.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet, and answers for numerical-response questions are recorded in the second section on the same side of the same machine-scored answer sheet. Answers to the written-response questions are written right in the exam booklet.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a list, and determination of a sequence of events. Specific instructions for recording answers for each type of numerical-response question are provided in the instruction pages of each Biology 30 diploma examination. It should be noted that the correct answer for any one question will not necessarily require use of all four columns in the grid provided on the answer sheet.

The written-response portion of each Biology 30 diploma examination contains two contextual questions: a closed-response question and an open-response question. Each question has a value of 15 percent.

The closed-response question presents a synopsis of a research project. Pertinent data are provided in the form of graphs and/or tables. The several parts of this question require students to demonstrate a variety of science process skills.

NEW

The open-response question presents a problem **also based on current research** that requires students to make connections between biological concepts, technology, and/or social issues. Furthermore, an acceptable response will demonstrate good communication skills.

Assessment of STS Connections

Students' understanding of the concepts of science are measured by every question on the examinations. In addition, some questions measure the students' development of the skills and thinking processes associated with scientific inquiry. Some questions will measure students' understanding of the interrelationships between science and technology and among science, technology, and society.

Students are advised that no one viewpoint will be considered more worthy of serious consideration than another in response to an open-ended question. Holistic scoring of "issues" and "decision-making" questions will be guided, however, by the following principles:

- The problem-solving process should be organized, rigorous, and intellectually sound; that is, the process should not be based on emotional assertions and uninformed opinions
- Analyses of moral dilemmas should focus on the **goals**, **rights**, and **duties** of the participating groups
- All credible arguments should meet two standards:
  - —valid conclusions must follow from the reasons by accepted rules of logic
  - —all reasons must count as good reasons for everyone

Note: If a person's particular religious belief or conviction can be shown to be important to everyone, then the belief can be counted as an argument. If the religious belief is of parochial significance only, then it cannot be counted as an argument, although it is still important to the person who proposed it. This approach should also apply to moral beliefs, including those of non-religious origin.

References:

"Mapping and Sequencing the Human Genome: Science, Ethics, and Public Policy." BSCS and the American Medical Association, Colorado Springs: BSCS (1992).

McInernery, J. D. "Ethical values in biology education." *Ethics and Social Responsibility in Science Education.* Toronto: Pergamon Press (1986), pp. 175–181.

Morris, Linda J. "Bioethical Dilemmas, Decision-making and the Human Genome Project." *The Science Teacher*, February, 1994, pp. 39–41.

Assessment of Communication Skills

Communication skills are assessed most directly in the teacher-scored questions. For the open-response questions, the descriptions used in the holistic scoring guides may include criteria for assessing communication skills along with criteria for the other components. The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include:

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific.

Course Clarifications

NEW

Pedigree Analysis

A major clue for the identification of a dominant disorder is the appearance of the phenotype in every generation. Male and female parents transmit to both male and female children.

A major clue for the identification of a sex-linked recessive disorder is the presence of affected sons, as male offspring receive transmissions only from the mother, whereas female offspring receive transmissions from both the mother and father.

Abnormal alleles can arise de novo by mutation.

Chromosome Formation

Genetic material appears as fine, bumpy threads weaving through the nucleoplasm. Known as chromatin, each thread is a single molecule of DNA and protein until replication of the DNA results in each thread becoming a doubled molecule of DNA and protein held together by a centromere.

Following the replication of DNA, the chromatin coils and condenses enormously to form short, barlike bodies called **chromosomes**. At this time, each chromosome consists of two strands, or **chromatids**. During cell division (the processes of **mitosis** or **meiosis** [anaphase II]), the two chromatids of each **chromosome** are separated. Cells formed as a result of cell division contain one chromatid from each chromosome. The term **chromosome** is used to describe this single molecule of DNA and protein that now uncoils and becomes, once again, a fine, bumpy thread of **chromatin** in the nucleoplasm.

Counting Chromosomes

Replication yields chromosomes that appear doubled, two chromatids held by a centromere. Division yields chromosomes that are single. For an accurate count of chromosomes, count the centromeres.

Succession

This concept is traditionally explained as a process of change that occurs as a result of a disturbance. Succession is often described as a series of predictable changes in communities that result in a final, stable climax community. This explanation originated in 1916 by F.E. Clements and is directional and deterministic. Succession does not usually occur in this manner, but many high school textbooks perpetuate this misconception. A better description of succession de-emphasizes directionality and explains that disturbance produces new habitats, which leads to immigration, which affects communities that determine the gene pool. Immigration leads to colonization, which leads to emigration; with the net result being a change in character of the community or succession. No one final stage may exist since there may never be an absence of disturbance, or because the length of time between disturbances is insufficient, or because for some vegetation disturbance is necessary to maintain the community.

Community Stability and Diversity

Traditionally, this relationship has been described by the saying *as community diversity increases, stability decreases.* In contrast, a stable community may be very diverse, such as the populations found in a tide pool, or may show little diversity, such as an old-growth boreal forest.

Population Formulas

The growth of populations is described in terms of the mathematical relationship among carrying capacity, biotic potential, and the number of individuals in the population.

Population density is $D_p = \frac{N}{A}$, Where the number of organisms (N) in a specified area (A) is defined as the density of the population (D_p)

Change in population size is

$$\Delta N = \text{(factors that increase pop)} - \text{(factors that decrease pop)};$$

$$\text{that is, } \Delta N = \text{(births + immigration)} - \text{(deaths + emigration)}.$$

Per capita growth rate is $\text{cgr} = \frac{\Delta N}{N}$ (time will be determined by the specific question); that is, cgr is the change in population per unit time divided by the initial number of organisms in the population.
Cgr may be expressed as a percent: $\text{cgr}(\%) = \frac{\Delta N \times 100}{N}$.

Growth rate may be exponential or sigmoidal;

$$\frac{\Delta N}{\Delta t} = rN$$

describes exponential growth rate where the change in population size over time is the product of the biotic potential and original population.

$$\frac{\Delta N}{\Delta t} = rN\,\frac{(K - N)}{K}$$

describes sigmoidal growth rate where the change in population size over time is the product of the biotic potential and original population times (the carrying capacity minus the original population divided by the carrying capacity). As the population size approaches carrying capacity, the growth rate of the population decreases.

Carrying Capacity

Carrying capacity refers to the maximum number of individuals of a species that can be supported by the resources of an environment without damage to those resources. The carrying capacity is not fixed; it may change drastically from one time to another. It is symbolized by K.

Chaos Theory

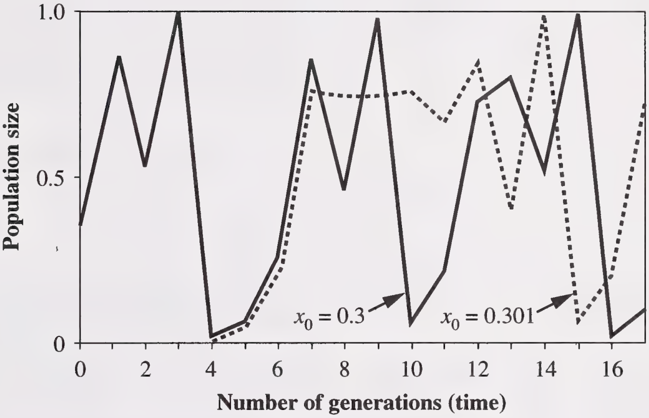
Until recent times, ecologists believed that density-dependent factors kept the size of a population at a relatively stable level and that fluctuations in that stable level were the result of unpredictable changes due to various environmental influences. Thus, determining the pattern of growth for a population meant looking for the stable level among the apparently random fluctuations.

Chaos refers to the apparently random outcomes or behaviours of complex systems, including many biological systems. Chaos theory suggests that ordered events obeying the simple laws of these complex systems lead to these apparently random behaviours. If this is the case, mathematical models using simple laws may be developed to predict the chaotic (apparently random) behaviour of complex systems, including population growth patterns. Other areas of biological interest include population growth patterns (particularly epidemiology), genetic variability in natural populations, escape behaviour of prey, onset of symptoms of cardiac arrhythmias, and neurological disorders such as Parkinson's disease.

The implications of Chaos Theory for the study of population growth pattern might include any of the following:

1. Researchers are conducting studies wherein they try to identify chaos in systems. Attempts are then made to make predictions about the behaviour of these systems with the use of mathematical models.

2. When chaos theory is applied to similar populations (obeying the same growth laws) that have only slightly different conditions, very different growth patterns at later stages occur. Mathematical models show that when slight changes are made to initial population conditions, population growth patterns can diverge greatly.



This figure shows how sensitive the growth of a population is to the initial conditions when the dynamics are chaotic. Although the initial values for two populations differ only by 0.3 percent, their trajectories rapidly diverge. (x_0 refers to the sum of the initial conditions.)

3. Realization should be made that even the most simple systems can generate even the most apparently random and chaotic behaviour.

Graphing

A graph presents numerical information in a pictorial form. Three kinds of graphs are commonly used.

1. Line graph
   - used to display the relationship between continuous data
   - demonstrates a progession of values or shows how one variable changes in relation to another variable; for example, growth of a child with age.

   Note: When equations are graphed, a line is drawn.

2. Bar graph
   - used to display discrete or discontinuous data
   - consists of parallel bars whose lengths are proportional to quantities given in a set data. The items compared are plotted along the horizontal axis and appropriate measurement is plotted along the vertical axis. The numbers and types of protists in a lake may be illustrated in a bar graph.

3. Scatter graph
   - used to display the relation between two random variables
   - length of an experiment and number of bacteria grown may be illustrated in a scatter graph. A line of best fit may be shown on the graph.

Generally, the same rules for graphing apply to all three types of graphs. These rules include:

1. The graph must have a title. The title represents the relationship between the two variables.
2. The independent (manipulated) variable is diagrammed on the horizontal X-axis.
3. The dependent (responding) variable is diagrammed on the vertical Y-axis.
4. Each axis is specifically labelled according to the variable it represents, and units are provided with equal increments. The scale does not have to be the same on both axes, but the scales must accommodate the ranges of the two variables.
5. Data are plotted. The graph may show exact numbers or a general relationship. A best fit line is often used in line and scatter graphs where a straight line is a rough linear estimate with values equally divided above and below the line.
6. A legend may be used to identify multigraph lines.

Textbooks Recommended by Alberta Teachers

Begon, Michael, et al. ***Ecology** Individuals, Populations and Communities. 2nd ed.,* Don Mills, Ontario: Oxford University Press, 1990. ISBN 0-632-02344-9.

Campbell, Neil A. ***Biology***. 3rd ed., Don Mills, Ontario: The Benjamin/Cummings Publishing Company, Inc., 1993.
ISBN 0-8053-1880-1.

Griffiths, Anthony, et al. ***An Introduction to Genetic Analysis***. 5th ed., New York: W.H. Freeman and Co., 1993. ISBN 0-7167-2285-2.

Mader, Sylvia S. ***Inquiry into Life***. 6th ed., Dubuque, I.A:
Wm C. Brown Publishers, 1991. ISBN 0-697-13280-3.

Mange, Arthur P., and Elaine J. Mange. ***Genetics: Human Aspects***. 2nd ed., Sunderland, Massachusetts: Sinauer Associates, Inc., 1990.
ISBN 0-87893-501-0.

Marieb, Elaine N. ***Human Anatomy and Physiology***. 3rd ed.,
Don Mills, Ontario: The Benjamin/Cummings Publishing Company, Inc., 1995. ISBN 0-8053-4281-8.

One-Marker Scoring System

Each Biology 30 Diploma Examination has two written-response questions, one of which is a closed-response question. The students' answers to this question are scored by one teacher using an analytic scoring guide. Each guide lists criteria required for each mark along with a sample response that meets all the criteria for a score of 12. The following example is taken from the January 1996 Biology 30 Diploma Examination.

Sample Question and Scoring Guide

Use the following information to answer the next question.

NEW

The Saguenay River community, located about 200 km from Quebec City, has the world's highest incidence—1 in 500—of myotonic dystrophy. It is an inherited disease that affects the muscles and nerves of its victims. Typically, myotonic dystrophy affects 1 in 7 500 Canadians.

An international research team has isolated the gene that causes this disease. The myotonic dystrophy gene has an interesting characteristic: the gene size expands with each generation through the addition of extra nitrogen bases. The greater the degree of expansion, the greater the severity of symptoms. In addition, greater gene expansion increases the likelihood of offspring being born with myotonic dystrophy. Diagnosis of carriers can now be done with a simple blood test.

A twenty-four-year-old woman and a twenty-two-year-old man from the Saguenay River community were both unaffected by myotonic dystrophy. They sought genetic counselling before marriage. The counsellor collected data from their living relatives and recorded the information in a table.

Woman's Family

Relative	Age	Myotonic Dystrophy
maternal* grandmother	69	no
maternal grandfather	71	yes
mother	48	no
father	49	no
sister	21	no
brother	23	yes

Man's Family

Relative	Age	Myotonic Dystrophy
paternal** grandmother	77	no
paternal grandfather	74	no
paternal grandmother's brother	78	yes
mother	46	no
father	51	yes
brother	20	no
sister	19	yes

* Maternal means "on the mother's side of the family."

**Paternal means "on the father's side of the family."

Written Response – 15% (12 marks)

1. **a.** Provide a hypothesis to explain why the incidence of this disease is higher in the Saguenay River community than in the rest of Canada.

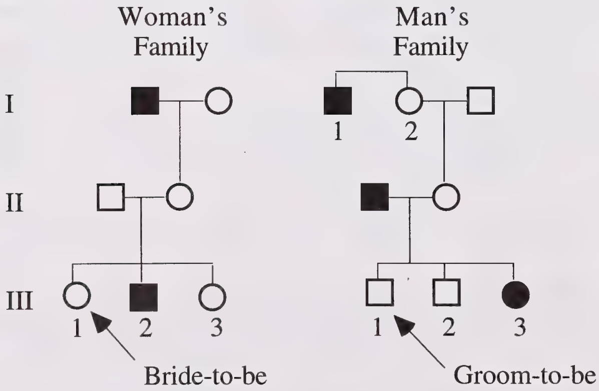
*Award **1** mark for any of the following responses.*

- If a mutation is present or occurs in a small reproductively isolated population, then its frequency may remain high. Over time, the choice of mates includes many others with that allele.
- This is a type of genetic drift: founder effect.
- Some environmental factor interacts with the genome, causing effects such as selecting for the allele OR triggering a silent gene OR acting as a mutagen.

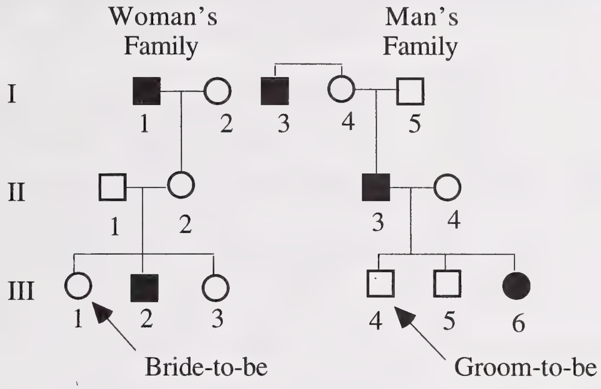
b. Construct a pedigree to illustrate the data in the table and the information given about the man and the woman who are seeking genetic counselling. Use the symbols shown on the tear-out data pages when constructing your pedigree.

*Award **3 marks*** if 15 individuals and relationships are correctly displayed. Offspring are in birth order or numbered to show birth order. Generations are clearly identified.
*Award **2 marks*** if individuals and relationships are correctly displayed but the offspring are not correctly sorted by age OR generations are not clear OR an incorrect number of individuals are shown, i.e. one error.
*Award **1 mark*** if enough individuals and relationships are correctly displayed to draw genetic information from both families, i.e. 2 or more errors.
*Award **0 marks*** if insufficient accurate relationships and individuals are presented. No useful inferences possible.

BIRTH ORDER NUMBERING



OR **REFERENCE NUMBERING**



Note: Labelling "Bride-to-be" and "Groom-to-be" is optional.

c. Based on the data, identify the mode (type) of inheritance for myotonic dystrophy. Describe one piece of evidence to support your choice.

Award 1 mark for identifying the mode as sex linked OR autosomal

Award 1 mark for describing evidence.

- Sex-linked supporting evidence:
  There are more affected males than affected females showing on this pedigree. It looks like myotonic dystrophy is on the X chromosome because in the woman's pedigree the mother transmits the allele to her son and in the man's pedigree the father transmits the allele to his daughter but not to his sons.
  OR
- Autosomal supporting evidence:
  One of the five affected individuals is female (20%). This proportion is more similar to that expected for autosomal characteristics. In the woman's pedigree, the mother and father could both be heterozygous for the condition with the resulting offspring. In the man's pedigree, even if the father was homozygous recessive and the mother was a heterozygote, the observed phenotypes would be possible.
  OR
- Evidence for recessive if sex linked or autosomal is not specified.
  In the woman's pedigree, the phenotype misses a generation. If it were dominant, the phenotype would appear in every generation.
  OR
- Evidence for specifying that sex linked or autosomal are both plausible.

d. If the man and woman who are seeking genetic counselling married and had a child, predict the probability that the child would have myotonic dystrophy. Show your method and/or calculations.

Sex linked:

- if sex linked, then the female could be X^MX^m or X^MX^M
  if sex linked, then the male is X^MY
- therefore, there is a $\frac{1}{2}$ chance that the female is a carrier
- if the woman is a carrier, then there is a $\frac{1}{4}$ chance she will have an affected offspring; if she is a non-carrier, there is 0 chance

	X^M	X^m
X^M	X^MX^M	X^MX^m
Y	X^MY	X^mY

← affected offspring

- because these are independent events, you must multiply the probabilities

$$\frac{1}{2} \times \frac{1}{4} = \frac{1}{8} \text{ or } 0.125$$

Autosomal:

- if autosomal, the female could be MM or Mm and
  the male could be Mm only
- therefore, there is a $\frac{2}{3}$ chance that the female is a carrier, a $\frac{1}{3}$ chance she is a non-carrier.
- if the woman is a carrier, then there is a $\frac{1}{4}$ chance she will have an affected offspring; if she is a non-carrier, there is 0 chance

	M	m
M	MM	Mm
m	Mm	mm

← affected offspring

- because these are independent events, you must multiply the probabilities $\frac{2}{3} \times \frac{1}{4} = \frac{2}{12}$ or 0.167

Award 2 marks if the student considered both possible genotypes for the woman and stated the probability in each case (0.25 and zero) OR combined the probabilities to obtain $\frac{1}{8}$ or $\frac{1}{6}$ or 0.125 or 0.167 respectively

Award 1 mark if the student considered only that the woman was a carrier and obtained $\frac{1}{4}$ or 0.25 or 25% as his or her answer OR only that the woman was not a carrier and obtained 0%

e. To what degree would your pedigree be useful for predicting the severity of myotonic dystrophy in offspring?

Not at all useful __ Not useful __ Useful __ Somewhat useful __ Very useful __

Explain.

Somewhat useful or **useful** should be checked off, BUT there are no marks awarded for this.

Severity of the disease is determined by how long the gene is. This is determined by how many generations that it has been in existence. If this couple had an affected offspring, the disease would be more severe than in the affected relatives since this is now the 4th generation.

*Award **1** mark for the student's explanation.*

f. As the genetic counsellor for the man and woman considering marriage, prepare a **brief report**. In your report, outline **three recommendations** and/or **cautions** you might give this couple. Your recommendations and/or cautions should be based **on the data and on scientific information**.

Recommendations:

- have the blood test to determine whether they are a carrier of this gene or not
- if one or both are carriers (autosomal), explain to them their chances of having an affected offspring; for example, if they are both carriers, the chances of having an affected offspring is 25%; if neither are carriers, then there is no chance of having an affected offspring
- if their chances of having an affected offspring is high, recommend adoption, fetal screening, perhaps not having children, or alternate reproductive technology
- mitigating home/school modifications to accommodate a lifetime with this disorder; using various technologies

Cautions:

- if they are carriers and they do have an affected offspring, then the child will have a more severe case of myotonic dystrophy than affected relative have
- if the fetus is screened and found to be affected, what will they do with this information?

Accept other relevant points if based on data and on scientific information.

Note: Mark the student's best three if more than three are written.

*Award 3 **marks*** if **three recommendations and/or cautions** are provided.
*Award 2 **marks*** If **two recommendations and/or cautions** are provided.
*Award 1 **mark*** if **one recommendation and/or caution** is provided.

Two-Marker Scoring System

The other written-response question is an open-response question. Students' answers to the open-response question are scored by teachers using a holistic scoring guide. The guide describes the characteristics of students' answers that correspond to one of five values: 0, 1, 2, 3, or 4. Each student's answer is scored independently by two teachers. The two scores are added together for a combined total sub-score out of 8.

If the two scores obtained by the two independent readings represent a difference of 2 or more scale categories on the guide, the scores are classified as *discrepant*. Student responses that have *discrepant* scores are read by a third reader. The third reader will assign a score that is within the limits established by the discrepant scores of the first two readers. This score will be multiplied by 2 for a total sub-score out of 8.

The sub-score out of 8 is then pro-rated out of 12. A summary of the calculations follows:

Reader 1 Score _____ out of 4
Reader 2 Score _____ out of 4
Sub-score _____ out of 8

$$\frac{\text{Pro-rated Raw Score}}{12} = \frac{\text{Sub-score}}{8} \times 1.5$$

The following example is taken from the June 1996 Biology 30 Diploma Examination.

Sample Question and Scoring of Sample Answers

Use the following information to answer the next question.

NEW

> The islets of Langerhans are small clusters of cells in the pancreas. They monitor and regulate blood glucose levels. In patients with type I *diabetes mellitus*, the islet cells no longer produce one of the major hormones necessary to control blood glucose levels. Until about 75 years ago, these patients died within months of the onset of the disease. Today, these patients are treated to control blood glucose levels, and they are able to live relatively normal lives. However, many of these patients eventually do suffer from diabetes-related disorders caused by abnormal fluctuations in blood glucose levels. These fluctuations can damage blood vessels and may result in blindness, kidney failure, and blood circulation problems in the feet and hands.
>
> Recent research has focused on transplanting islet cells from a donor pancreas into a diabetic patient. The islet cell clusters are separated from other pancreatic cells and injected into the large vein that leads into the patient's liver. The clusters lodge in small blood vessels in the patient's liver and begin to produce hormones in response to changing blood glucose levels.

Written Response – 15% (12 marks)

2.

- Identify the hormone lacking in a person with type I *diabetes mellitus*, and explain two physiological mechanisms by which this hormone regulates blood glucose levels. Draw a feedback loop that illustrates this regulation.
- Explain why successful islet cell transplants may prevent some of the physiological problems experienced by many patients with *diabetes mellitus.*
- Describe two technological issues and one societal issue that researchers might have faced during the development of the islet cell transplant procedure.

Students' responses may include some of the following information.

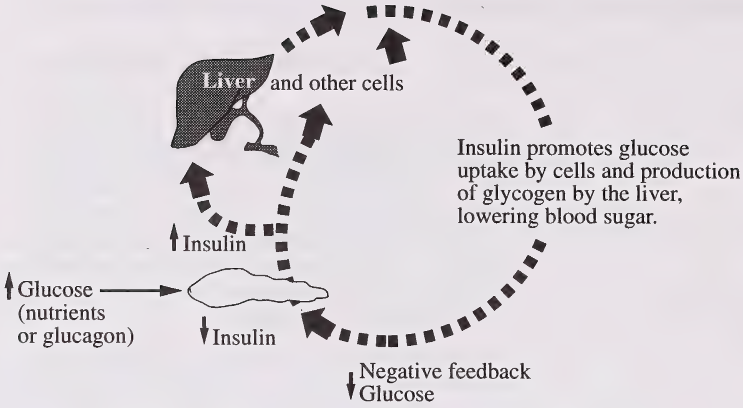
Insulin is lacking in people with type I *diabetes mellitus*. Insulin regulates blood sugar levels by

—making membranes more permeable to glucose. Glucose leaves the blood and enters cells where it can be used as an energy source.

—promoting the conversion of glucose to glycogen in the liver/muscles.

—promoting the oxidation of glucose.

—inhibiting metabolic reactions that generate glucose.


Liver
and other cells
Insulin promotes glucose uptake by cells and production of glycogen by the liver, lowering blood sugar.
↑Insulin
↑Glucose (nutrients or glucagon)
↓Insulin
Negative feedback
↓Glucose

Transplanted islet cells should respond by providing insulin with the speed and accuracy of a normal pancreas. This would eliminate the blood glucose level fluctuations, which cause the problems associated with diabetes.

Possible technological issues include:

- —identification of islet cells
- —isolation of islet cells (surgical complications; e.g., infection control, separating beta cells from alpha cells)
- —keeping isolated islet cells alive
- —the number of cells to be transplanted
- —the method of introducing the islet cells into the body
- —monitoring the effects of the transplant (benefits, side-effects, duration)
- —preventing the rejection of the transplanted cells
- —availability of instruments and processes (costs, development)

(Other issues may be appropriate, if linked clearly to the transplant procedure)

Possible societal issues include:

- —funding for research (cost/benefit)
- —finding donors for the research
- —finding volunteers for the research
- —influencing gene pool
- —decreased mortality causes population growth

(Other issues may be appropriate, if linked clearly to the transplant procedure)

Holistic Key for Written-Response Question 2

Score	Scoring Description		
	Science	**Technology/Society**	**Presentation**
4 **Standard of Excellence** The response addresses all of the major points of the question.	• The response identifies insulin, explains two mechanisms by which it regulates blood sugar levels, and diagrams the feedback loop. • The response explains why islet cell transplants could prevent problems associated with fluctuating glucose levels.	• Two technological problems are described • One societal issue is described.	• Explanations of concepts are clear, concise, and logical. • Complete, grammatically correct sentences are used. • Effective use of scientific vocabulary is presented. • Consistency of thought is demonstrated. • The response is well organized.
3 The response addresses most of the major points of the question.	• The response identifies insulin, describes one mechanism by which it regulates blood sugar levels, and sketches the feedback loop. • The response explains why islet cell transplants could prevent symptoms associated with diabetes.	• One technological problem is described • One societal issue is described.	• Explanations of concepts are clear. • Complete sentences are used. • Some appropriate use of scientific vocabulary is presented. • Consistency of thought is demonstrated. • The response is organized.
2 **Acceptable Standard** The response addresses some of the major points of the question.	• The response identifies insulin and identifies one mechanism by which it regulates blood sugar levels. OR The response identifies insulin and sketches the feedback loop. • The response indicates that insulin will alleviate some symptoms of diabetes.	• One technological problem is identified. • One societal issue is identified. OR • One issue is described.	• Most explanations of concepts are clear. • Some use of appropriate scientific vocabulary is presented. • Some organizational skills are evident.
1 The response addresses few of the major points of the question.	• The response identifies insulin.	• One technological problem or societal issue is identified.	• Little appropriate use of scientific vocabulary is presented. • Organizational skills are not evident.
0 The response does not address the major points of the question.	• The science is inaccurate or not addressed.	• Technologies or issues are not identified or are not accurate.	• No appropriate use of scientific vocabulary is presented. • Organizational skills are not evident.

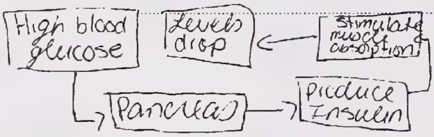
Sample Answers

The sample answers for this question were scored by a group of classroom teachers using the scoring criteria on the previous page.

Sample Answer—Score 4

A correct identification of insulin is followed by a description of one mechanism by which insulin lowers blood glucose levels. A simple diagram of a feedback loop conveys an understanding of feedback, and a explanation that islet implants prevent blood glucose level fluctuations further demonstrates a consistency of thought regarding the function of insulin. Two technological issues are thoughtfully described, along with one societal issue. Overall, this response, although lacking one physiological mechanism, represents a score of 4.

Insulin is lacking in a person with type I diabetes mellitus. Insulin is released when glucose levels in the blood are high, it makes the muscles in the body absorb the glucose and use it for energy. if glucose levels are low insulin production is stopped so that glucagon can be released to raise levels to a safe range where insulin can once again be released and used.



If islet cell transplants are successful then problems like blindness, kidney failure, poor circulation and damaged blood vessels could be prevented because there would be a constant level of glucose in the blood instead of wide spread fluctuations. These fluctuations can lead to problems like kidney failure because the high levels of glucose are damaging, there is too much glucose for the kidney to filter.

Two technological issues may have been how to transplant the islets and not have to recieving body attack them as a foreign substance that was to be rejected and destroyed. Another technological issue may have been how to inject the islets with damaging the recieving person's liver. They may have tried placing the islets in a different body organ before they found that the liver worked best. They would of had to decide how close to the liver the injection should be.

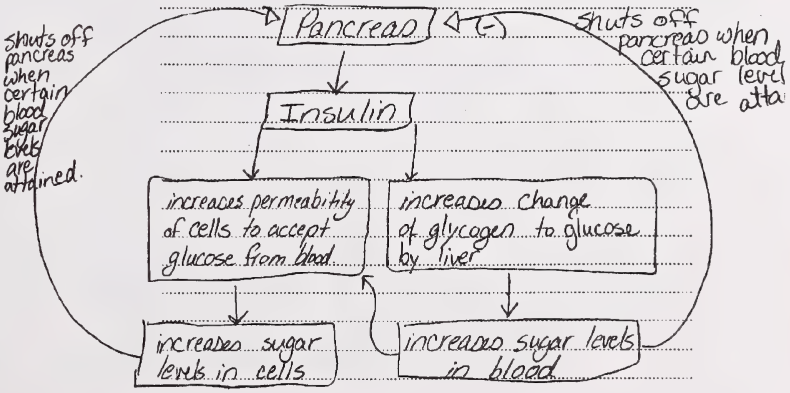
One societal issue that may have been faced is the cost of this operation and research. If the technology is expensive how wise is this technique to use since long term problems have not yet been researched? Also how easy is it to get donated pancreas's which are healthy and worth working with?

Sample Answer—Score 3

A correct identification of insulin is followed by an acceptable description of one mechanism by which insulin lowers blood glucose levels. The second physiological mechanism is flawed, and this error is carried into the illustration of a feedback cycle; the illustration nonetheless conveys an understanding of the concept of negative feedback. Islet cell transplants are correctly identified as producers of insulin, and a general description is given that indicates why some symptoms associated with diabetes would be prevented. The descriptions of two technological issues and one societal issue complete a well-organized response that addresses most of the major parts of this question.

Someone who has type I diabetes mellitus is lacking the hormone insulin, which is produced by the pancreas. Insulin is necessary for cells to function normally. Insulin controls the permeability of glucose to enter cells. In diabetes mellitus, glucose is not able to enter the cells. Insulin also initiates the liver to change stored sugars (glycogen) into glucose that is used by their body. If someones body is not producing insulin then they must take injections of insulin through a needle daily.

Negative Feedback Loop:


Pancreas
(-)
shuts off pancreas when certain blood sugar levels are atta
shuts off pancreas when certain blood sugar levels are attained.
Insulin
increases permeability of cells to accept glucose from blood
increases change of glycogen to glucose by liver
increases sugar levels in cells
increases sugar levels in blood

The transplant of the islets of langerhans increase the level of functioning insulin in the blood. This will make the cells permeable to glucose, and thereby allowing them to work properly. This will reduce the chances of blindness, kidney failure, blood circulation problems and damage to blood vessels. In general, it will improve someone's life by decreasing the stress caused by anticipating these potential problems.

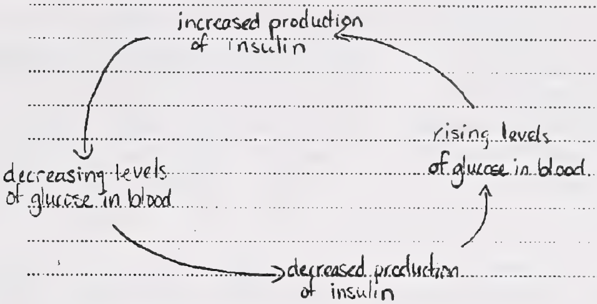
Two technological issues that researchers would have had to face before they could make the first transplant are issues that are faced before any transplant takes place. Will the donor be able to provide this tissue (the islets of langerhans) without any permanent damage or risk of their lives? Another issue is, will the person with type I diabetes mellitus accept the islets of langerhans even though it is foreign, or will the patients antibodies try and kill it?

A societal issue related to the situation of transplants has been quite evident in the news media. With increasing health care cutbacks and a "pay your own way" attitude adopted by the Alberta government, who pays for procedures such as this. If it is not covered by health care (as many experimental procedures are not) and the patient can not pay for it, should they rely on public support through donations, or is the public already paying enough through taxes? This is a very tough issue that must be addressed, and can not be solved on the opinions of one person.

Sample Answer—Score 2

This response correctly identifies insulin and provides an adequate description of one mechanism by which insulin lowers blood glucose levels. The feedback loop is rudimentary, but does show some understanding of blood glucose regulation by insulin. Islet cell transplants are correctly identified as producers of insulin; however, the description of why symptoms of diabetes would be alleviated is vague. Two technological issues are identified but their descriptions are too general; the societal issue, when addressing the morality of interfering with nature, should focus on the goals, rights, and/or duties of humans. Therefore, the description in this response is not specific enough.

The hormone lacking in a person with type I diabetes mellitus is insulin, which regulates blood glucose levels. One mechanism by which it regulates these levels is called negative feedback.


increased production of insulin
rising levels of glucose in blood
decreasing levels of glucose in blood
decreased production of insulin

The more glucose there is in the blood, the more insulin will be produced to transform it into glycogen, so the body can store it. This will decrease the amount of glucose in the blood, which, in turn, will decrease production of insulin.

Successful islet transplants would prevent many patients from experiencing the physiological problems associated with this disease because, first of all, there would be islet cells present producing the necessary hormone, and second, this hormone is being produced in a more natural way than with medication, so there would be fewer, if any, side effects.

One technological issue possibly raised during the development of this process could have been possible dangers to the patient if the procedure did not work, if the donor's islets didn't function properly in the patient's body.

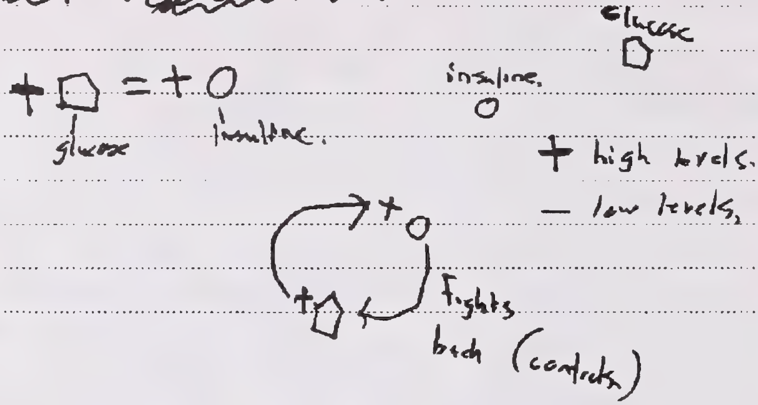
One societal issue that may have been addressed during the development of this procedure could have been whether or not it is moral to interfere with nature. Some people might believe that it's wrong for science to alter any condition that occurs naturally.

Another technological issue that may have been raised could be that of whether or not a patient's body may develop, over time, a resistance to the donor's islets causing decreased efficiency.

Sample Answer—Score 1

The response identifies insulin but fails to provide physiological mechanisms of the hormone, a meaningful feedback loop illustrating control of blood glucose levels, or an identification that islet implants produce insulin. An identification of two possible issues (tissue rejection and finding donors) is made but an accurate description of these issues is lacking and demonstrates only minimal understanding of these issues. Little appropriate scientific vocabulary is used.

The hormone being described Here is insuline. A person with the diabetes mellitus lacks Insulin. Insuline is used to break down Glucose and convert it to energy it is also a [illegible]



If the islets could be replaced than there would be regulation of Blood Sugar levels. This would prevent almost all of the physiological problems that come from ~~diabetes~~ because these problems start because of lack of monitoring of blood glucose levels. There would be less fluctuation thus stopping blood vessels from becoming damaged.

2 Technological problems you might face is Genetic code. If the islets are not the same blood type or Genetic code than they might not work. Transplanting such a small part successfully was probably another problem.

The biggest problem socialogically is finding donors.

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Background

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technological developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diploma examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writing diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of information that can be stored in calculators that are brought into diploma examinations. Calculators that have built-in notes (definitions or explanations in alpha notation) that cannot be cleared are not permitted.

2. Students must clear calculators that are brought into diploma examinations of all information they have stored except for
    a. programs used for computing values of the formulas on the diploma examination data tear-out pages or in the data booklets,
    b. programs used for graphing quadratic relations as found in the Mathematics 30/33 Interim Teacher Resource Manual.

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlining operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
    a. all calculators operate in silent mode,
    b. students do not share calculators or information contained within them,
    c. calculator cases are stored on the floor throughout the exam, and
    d. all examination rules are followed.

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science Unit, Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

Alberta
EDUCATION
Revised 30 August 96

Appendix B

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Sciences Diploma Examinations

Significant Digits (measured values)

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   12.3 (least precise)
   0.12
   12.34
   24.76

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   (1.23)(54.321) = 66.81483

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity in the original data with the fewest number of significant digits. For example:

   In determining the value of (1.23)(4.321)/(3.45 – 3.21), three calculations are required:

   a. 3.45 – 3.21 = 0.24

   b. (1.23)(4.321) = 5.31483

   c. 5.31483/0.24 = 22.145125

      [Not 5.31/0.24 = 22.125]

   The value should be rounded to 22.1.

   Note: In the example given, steps *a* and *b* yield interim values. These values should not be used in determining the number of significant digits.

NEW

4. When calculations involve exact numbers (counted and defined values) the calculated answer should be rounded based upon the measured value(s). For example:

   12 eggs × 52.3 g/egg = 628 g

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix C

Directing Words

Discuss

The word "discuss" will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity

The following words are specific in meaning.

Compare

Examine the character or qualities of two things by providing characteristics of both that point out their mutual *similarities* and *differences*

Conclude

State a logical end based on reasoning and/or evidence

Contrast/Distinguish

Point out the *differences* between two things that have similar or comparable natures

Criticize

Point out the *merits* and *demerits* of an item or issue

Define

Provide the essential qualities or meaning of a word or concept; make distinct and clear by marking out the limits

Describe

Give a written account or represent the characteristics of something by a figure, model, or picture

Design/Plan

Construct a plan, i.e., a detailed sequence of actions, for a specific purpose

Enumerate

Specify one by one or list in concise form and according to some order

Evaluate

Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages

Explain

Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail

How

Show in what manner or way, with what meaning

Hypothesize

Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically

Identify

Recognize and select as having the characteristics of something

Illustrate

Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram

Infer

Form a generalization from sample data; arrive at a conclusion by reasoning from evidence

Interpret

Tell the meaning of something, present information in a new form that adds meaning to the original data

Justify/Show How

Show reasons for or give facts that support a position

Outline

Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps

Predict

Tell in advance on the basis of empirical evidence and/or logic

Prove

Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons

Relate

Show logical or causal connection between things

Solve

Give a solution for a problem; i.e., explanation in words and/or numbers

Summarize

Give a brief account of the main points

Trace

Give a step-by-step description of the development

Why

Show the cause, reason, or purpose

Appendix D

Science Process Words

Hypothesis:	A single proposition intended as a possible explanation for an observed phenomenon; e.g., a possible cause for a specific effect
Conclusion:	A proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence
Experiment:	A set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations
Variables:	Conditions that can change in an experiment. Variables in experiments are categorized as: • *manipulated variables* (independent variables)—conditions that were deliberately changed by the experimenter • *controlled variables* (fixed or restrained variables) —conditions that could have changed but did not, because of the intervention of the experimenter • *responding variables* (dependent variables)—conditions that changed in response to the change in the manipulated variables
Technology:	The development of our understanding of science is directly related to the development of technology. The meaning of technology has many facets, but in general, technology refers to a way of doing something. This includes the development of tools and new techniques for solving problems. It also includes ideas and their organization for achieving practical purposes. In the context of an examination question, technology includes both these facets of meaning. That is, a technological explanation should include not only identification and descriptions of equipment (tools, products) but also explanations of procedures.

Appendix E

Data Sheets

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in population
A	area, space, or volume occupied by a population
t	time
Δ	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\frac{\Delta N}{\Delta t}$	change in population size during time interval
$>$	greater than, dominant over
$<$	less than, recessive to

Symbol	Description
♂	male
♀	female
n	chromosome number
B, b	alleles; upper case is dominant, lower case is recessive
I^A, I^B, i	alleles, human blood type (ABO)
P	parent generation
F_1, F_2	first, second filial (generation)
p	frequency of dominant allele
q	frequency of recessive allele

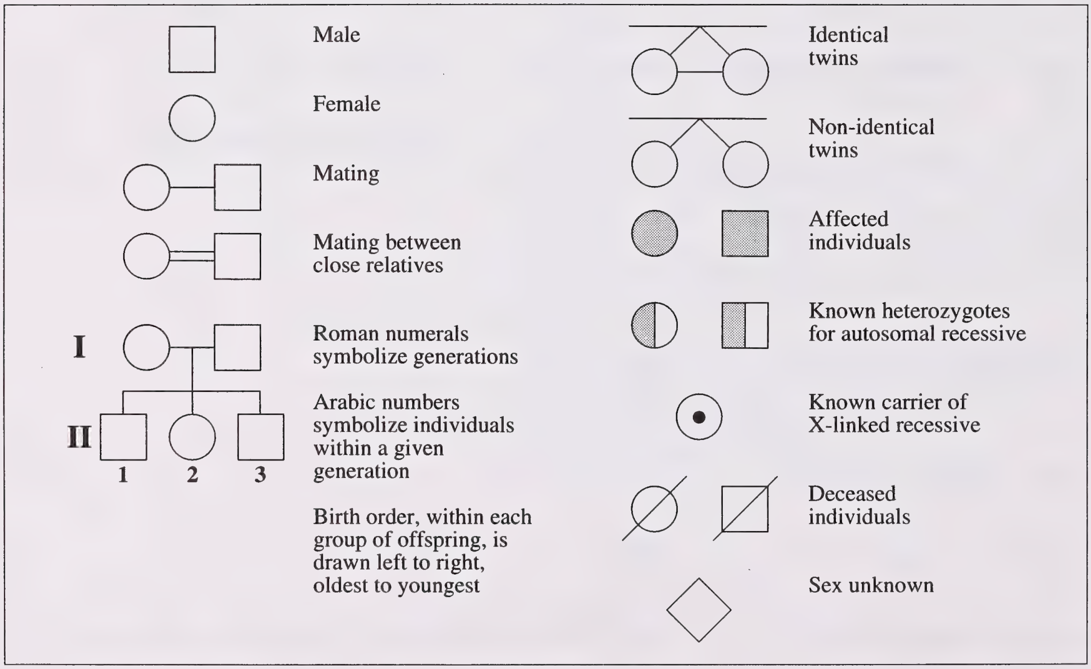
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{\Delta N}{\Delta t} = r\text{N}$ $\qquad$ $\frac{\Delta N}{\Delta t} = r\text{N}\frac{(\text{K} - \text{N})}{\text{K}}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols


Male
Female
Mating
Mating between close relatives
I
II
1
2
3
Roman numerals symbolize generations
Arabic numbers symbolize individuals within a given generation
Birth order, within each group of offspring, is drawn left to right, oldest to youngest
Identical twins
Non-identical twins
Affected individuals
Known heterozygotes for autosomal recessive
Known carrier of X-linked recessive
Deceased individuals
Sex unknown

Messenger RNA Codons and Their Corresponding Amino Acids

First Base	**Second Base**				**Third Base**
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon but also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	**Classification**	**Abbreviation**
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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